Geotechnical Engineering Investigation

Proposed

HSEB Building

University of Utah

Salt Lake City, Utah

PREPARED FOR:

DFCM

4110 State Office Building

Salt Lake City, Utah 84114

PREPARED BY:

C.A. CARTWRIGHT ENGINEERING

CAC PROJECT NO. 102138.0

November 15, 2002

CAC

CONSULTING

ENGINEERS

15th November 2002

DFCM
Attn. Lyle Kunudsen
4110 State Office Building
Salt Lake City, Utah 84114

Subject: Geotechnical Engineering Investigation
Proposed HSEB Building
University of Utah Campus, Salt Lake City Utah

C.A. Cartwright Engineering Project No. 102138.0

Mr. Kunudsen:

Submitted herewith is the report of our geotechnical engineering investigation for the subject site. This report contains the results of our findings, and an engineering interpretation of the results with respect to the available project characteristics. It also contains recommendations to aid in the design and construction of the earth related phases of this project.

On October 25th and 26th, 2002, a C.A. Cartwright Associates (CAC) engineer was on-site and completed four boreholes at the locations located by AJC Architects and campus planing. Soil samples were obtained during our investigation. Please note that we will store these samples for 30 days after the date on this report at which time they will be discarded unless you request otherwise.

Based on the findings of the subsurface investigation, and other information , the proposed site is suitable for the construction of a multistory structure provided the design and construction recommendations of this report are implemented correctly. Spread and spot footings placed on native, undisturbed, stiff or dense materials are recommended for the support of foundations. Detailed discussions of design and construction criteria are discussed in this report.

We appreciate the opportunity to be of service to you on this project. If we can be of further assistance or if you have any questions regarding this project, please do not hesitate to contact us at (435)-753-2850.

Sincerely,
C.A. Cartwright Engineering

Jay E. Apedaile, P.E. Phillip T. Pack, P.E.

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1.0 INTRODUCTION

C.A. Cartwright and Associates Engineering (CAC) was retained by DFCM to conduct a geotechnical engineering subsurface investigation for the proposed HSEB Building located on the campus of the University of Utah (U of U) between buildings 570 (BPRB Biomedical Polymers Research Bldg.) and 588 (NURS Nursing Bldg.) in Salt Lake City, Utah (see **Figures 1 and 2** in the Appendix).

The purpose of this study was to determine and describe the site subsurface conditions by: excavating 4 boreholes, obtaining samples, analyzing and evaluating field and laboratory test data, and providing recommendations regarding the earth related phases of this project.

Significant aspects regarding site development

- As we understand, the planned development calls for the construction of a multiple-story structure with 2 levels of underground parking.
- The planned building footprint and proposed loadings were unknown at the time of this report.
- Structural loads were not available at the time this report was prepared.
- A site-grading plan was not available at the time this report was prepared.
- It is anticipated that related site improvements will include access driveways with light vehicle use and walk ways with some light vehicle traffic.

When more information is known about the development of the site and its structure, DFCM should contact CAC so that an evaluation of the applicability of this report and the recommendations presented herein might be conducted.

2.0 FIELD AND LABORATORY INVESTIGATION

2.1 Field Investigation

The general subsurface conditions were investigated by drilling 4 boreholes, at the locations shown on **Figure 2** in the Appendix. Soil samples were obtained at a minimum of five-foot intervals or significant change of strata and in general accordance with ASTM D-420 and ASTM 2488. The subsurface conditions disclosed by the field investigation are discussed in Section 3.0.

Logs of the boreholes, including a description of all soil strata encountered, are presented in **Figures 3 - 6** in the Appendix. Sampling information and other pertinent data and observations are also included in the logs. In addition, a Soils Classification Sheet defining the terms and symbols used on the log, is provided as **Figure 7** in the Appendix.

2.2 Laboratory Investigation

Samples obtained during the field investigation were returned to the laboratory, inspected and classified in accordance with the Unified Soil Classification System (ASTM 2487). Selected laboratory tests were performed on representative soil samples to determine their classification and characteristics with respect to engineering design. Chart 1 indicates typical laboratory tests, which may be applicable to some of the samples retrieved from the site.

Chart 1 Laboratory Soil Testing

Test Conducted	Specification	To Determine
Moisture Content	ASTM D 2216	% moisture representative of field conditions
Dry Density	ASTM D 2937	Dry unit weighty representative of field conditions.
Atterberg Limits	ASTM D 4318	Plasticity and workability
% Pass #200 Sieve	ASTM D 1140	% fines in sample

The testing results are shown in the Summary of Test Data Chart presented in the Appendix as **Figures 8-10**. The final soil classifications are illustrated in the Borehole logs contained in the Appendix (**Figures 3-6**).

2.3 Engineering Analysis and Report

Data obtained from the exploratory borings and the laboratory-testing program were evaluated and used in the geotechnical analyses, which included the preparation of this report. This report presents our findings and recommendations developed during the study.

3.0 SITE CONDITIONS

Existing surface and subsurface conditions associated with the subject property are presented in this section.

3.1 General

The site is located on the U of U Campus between buildings 570 and 588 in Salt Lake City, Utah (see **Figures 1 and 2** in the Appendix). Topographically, the site slopes to the southwest and has been terraced for a parking loot. Going southwest across the site the elevation drops more than 10 ft.

3.2 Geologic Setting

The site appears to be formed from lacustrine silts sands and gravels related to the Lake Bonneville Period. These deposits consist primarily of non to low cohesive material, silt sands and gravel with traces of clay.

3.3 Sub-Surface Soils

Field and laboratory investigations indicate that the soil profile is relatively consistent throughout the site. A description of each borehole is presented below:

B-1 From just below the grass to approximately 8 feet below grade a silty sandy mixed material with rock and traces of brick, likely a FILL was encountered. From 8 to approximately 25 feet below grade a brown medium-dense silty SAND (SM) with layers of gravel, coarse sands, and traces of clay was observed. From 25 to 41 feet below grade a light brown dense silty SAND and GRAVEL (SM-GM) was observed. From 41 to approximately 47 feet below grade a light brown silty SAND (SM) with lenses of gravel and clay was observed. From 47 to approximately 57 feet below grade a very dense light brown silty sandy GRAVEL (GM) was observed. From 57 feet to the full depth explored (approximately 66 feet 6 inches below grade) a very stiff light brown SILT and CLAY (CL-ML) with sand and gravel, was encountered.

B-2 From 1-foot to approximately 21 feet below grade a brown stiff SILT (ML) with clay and some moisture was encountered. From 21 to approximately 40 feet below grade a brown very stiff to hard SILT (ML) with clay in lenses and some gravel and rock was observed. From 40 feet to the full depth explored (approximately 46 feet 6 inches below grade) a very dense sandy silty GRAVEL (GM) was encountered.

B-3 From 1-foot to approximately 24 feet below grade a stiff to very stiff brown SILT (ML) with sand and clay in lenses and a trace of rock was encountered. From 24 to approximately 33 feet below grade a light brown very dense silty SAND and GRAVEL (SM-GM) was observed. From 33 to 40 feet below grade a light brown very stiff gravelly CLAY (CL) with some sand and rock was observed. From 40 feet to the full depth explored (approximately 41 feet 6 inches below grade) a dense light brown clayey GRAVEL (GC) with sand was encountered.

B-4 From 1-foot to approximately 14 feet below grade a dense silty SAND (SM) with gravel and a trace of rock was encountered. From 14 to approximately 21 feet below grade a brown stiff SILT (ML) with gravel and a trace of clay was observed. From 21 feet to the full depth explored (approximately 26 feet 6 inches below grade) a dense brown silty GRAVEL (GM) with some rock and trace of clay was observed.

For a detailed description of the soil profiles encountered see the Borehole Logs (**Figures 3 – 6**) in the Appendix. See **Figure 2** for approximate borehole locations.

3.4 Ground Water

Ground water was not encountered in any of the borings. Numerous factors such as heavy precipitation, irrigation of neighboring land, and other unforeseen factors, may influence ground water elevations at the site. The detailed evaluation of these and other factors, which may be responsible for ground water fluctuations, is beyond the scope of this study.

3.5 Site Subsurface Variations

Based on the results of the subsurface exploration and our experience, variations in continuity and nature of subsurface conditions should be anticipated. Due to the nature and depositional characteristics of soils encountered at the site, care should be taken in interpolating or extrapolating subsurface conditions between or beyond the exploratory borings. Seasonal fluctuations in ground water conditions may occur.

3.6 Seismic Setting

3.6.1 General

The proposed site is located in a seismically active region. During the life of the project, seismic activity caused by active faults in the area has the potential of causing moderate to strong shaking. According to the findings of our subsurface investigation and according to the guidelines of the International Building Code (IBC, 2000) the **Site Class** would be classified as **D** (IBC, 2000; section 1615.1.1).

3.6.2 Faulting

The site is located adjacent to an exposed section of the Wasatch Fault. It is within 200-300 yds of the mapped fault (Utah Geological Survey). Based on fault-offset studies the fault zones are capable of generating a Magnitude 7.25 on the Rector Scale earthquake with ground surface offsets ranging from 2 to 5 feet.

3.6.3 Liquefaction

Liquefaction of a soil is defined as the condition when, a saturated, loose, cohesion-less, (fine sand-type) soils have a sudden, large decrease, in their ability to support. This is because of excessive pore water pressure, which develops during a seismic event. Cohesive (clay type) soils typically do not liquefy during a seismic event. The site subsoil's encountered have a low **liquefaction potential.**

4.0 DISCUSSION AND RECOMMENDATIONS

The following recommendations have been developed on the basis of the previously described project characteristics and subsurface conditions observed in the field and laboratory, as well as common engineering practice. Prudence and common engineering practices should be used in any foundation design.

4.1 Foundation Recommendations

Conventional spread and continuous wall foundations may be used for the support of a structure at the subject site. Based on field and laboratory data we recommend an **allowable bearing capacity of 3.0[1] kips/ft^2 be used for foundation design, provided that the following recommendations are observed:**

- Bearing soil shall be examined by a qualified geotechnical engineer, to insure that all topsoil, fill and other deleterious materials have been removed prior to the placement of the foundations.
- In footing excavations at foundation level, remove all large cobbles (>4 inches) and proof roll the bearing soils.
- Continuous footing width shall be maintained at a minimum of 24 inches.
- Spot footings shall be a minimum of 36 inches in width.
- Footings shall be placed on undisturbed soils, or compacted structural fill only. Any disturbed material or soft spots must be removed and replaced with compacted structural fill (Section 5.4.1).
- Exterior footings shall be placed a minimum of 36 inches below grade for frost protection.
- Great care shall be taken to limit the inclusion of water into the excavation during construction.

1. The 3.0 kips/ft^2 is based on a minimum depth of 5 feet below grade. Bearing capacity may be increased as the depth below the surface is increased in a linear fashion up to 12.0 kips/ft^2 at 20 feet below grade.

The allowable bearing pressure may be increased by 1/3 for temporary loads such as wind or seismic forces. Foundations designed and constructed in accordance with our recommendations could experience settlement . If the recommendations provided herein are observed, we estimate settlement should not exceed one inch, with differential settlements on the order of one-half inch. We expect approximately 75 percent of initial settlement to take place during construction.

4.2 Below Grade Structures

For design of the basement walls the following lateral soil pressures shall be used:

1. An equivalent fluid pressure of 55 pounds per cubic foot (pcf) for the active case. That is when the structure is allowed to yield, move away from the soil. This requires a minimum movement or rotation at the top of the wall of 0.001H, where "H" is the height of the wall (bottom of footing to top of wall).
2. 70 pcf for the at rest case. That is when the wall is not allowed to yield.
3. 300 pcf for the passive case. That is when the wall exerts pressure on the soil.
4. A coefficient of friction of 0.36 shall be used for the interface between the cast-in-place concrete footings and the native soils.

The given values for design are based on the use of native non-cohesive soil and are dependent on the type of soil that is used in backfilling. If imported soils other then native non-cohesive soils are used, we recommend that this office review the materials and the design earth pressures.

4.3 Drainage

Adequate surface drainage should be provided at the site to minimize any increase in moisture content of the foundation supporting soils and prevent water from migrating under the structures. All areas around the structures should be generously sloped to provide drainage away from these areas. We recommend a minimum slope of 6 inches in the first 10 feet away from the structure. We also recommend that the top 2 feet of back fill next to the foundation and above any utility opening in the foundation consist of a fine grained soil that will help to shed surface water away from the building.

4.4 Site Preparation and Grading

All topsoil, pavement, curb and gutter, utility lines, and any deleterious materials shall be removed from beneath the proposed structure. These types of removed material should not be used in any manner beneath footing foundations or as backfill against basement walls.

4.5 Pavements

All topsoil and deleterious materials shall be removed prior to placement of any pavement section. We expect site traffic to consist primarily of lightweight vehicle and pedestrian traffic. **Table 1** below contains the minimum recommended pavement sections based on an estimated CBR of 10.

TABLE 1 : PAVEMENT DESIGN

	Pavement Section Thickness (in)		
Material	**Pedestrian Traffic**	**Light Traffic**	**Loading docks, bus lanes, dumpster Pads**
Asphalt Pavement	**-**	**3**	
Concrete Pavement	**4**	**-**	**6**
Road-Base Material	**-**	**9**	**-**
Sub base	**-**	**-**	**6**
Total Thickness	**4**	**12**	**12**

It is further recommended that all topsoil is removed and the native soil is proof-rolled with heavy soil compaction equipment prior to the placing of road base and structural fill. If any areas appear soft, they should be removed and replaced with structural fill. **All structural fill materials overlying native soil should be compacted in accordance with section 5.3 of this report. The asphalt pavement should be compacted to 96% of the maximum density for the asphalt material.**

5.0 GENERAL CONSTRUCTION PROCEDURES AND RECOMMENDATIONS

The guidelines outlined below address the geotechnically related construction concerns for this project.

5.1 Foundation Excavations

Prior to placement of the foundations, all areas that will support foundation loads should be inspected to insure that all loose, soft or otherwise undesirable material is removed and that the structure will bear on satisfactory material. All topsoil shall be removed prior to the placement of foundations or pavements. Any loose or deleterious material should be replaced with a free draining granular fill as outlined in **Sections 5.3 and 5.4**.

If unsatisfactory material pockets are encountered in the excavation, the undesirable material should be removed and the elevation re-established by backfilling. This backfilling can be done with a lean concrete or a well-compacted structural fill as define in **Section 5.3** that follows.

All imported fill supporting footing loads should be compacted to at least 95 percent of the modified proctor maximum density (ASTM D 1557), provided the foundation is designed as outlined in **Section 4.1**. Compaction tests should be taken on each lift to insure the required compaction is being achieved.

All foundation excavations should be protected against any detrimental change in condition such as disturbance, rain and freezing. Surface runoff should be directed away from the excavation and not allowed to pond. If possible, all footing concrete should be poured the same day as the excavation is made. If this is not practical, the foundation excavation should be adequately protected and foundation placement should take place as soon as possible.

Excavation slopes shall maintain a maximum slope of 2 horizontal to 1 vertical. If it is required that slopes are steeper, it is necessary that excavation shoring/bracing be used.

5.2 Deep Excavations

The proposed structure could have excavations extending 30 feet below grade. Due to adjacent buildings and slope restrictions, we recommend that excavations use bracing and shoring to support the excavation sidewalls. This may consist of soil nailing, braced soldier piles and lagging or some other means be used to support the walls of the excavation.

An engineer from our office shall inspect all excavations prior to placement of the foundations, to insure that all loose, soft or otherwise undesirable material is removed and that the structure will bear on satisfactory material. Our engineer shall inspect all areas that will support foundation loads. Any loose or deleterious material shall be replaced with structural granular fill as outlined in Sections 5.3 and 5.4.

5.3 Fill Compaction

Any structural imported fill, supporting foundations should be compacted to a minimum of 95 percent of the Modified Proctor maximum laboratory density (ASTM D 1557).

Compaction should be accomplished by placing the fill in 8-inch loose lifts and mechanically compacting each lift to the specified minimum density. Field density tests should be performed on each lift as necessary to insure that compaction is being achieved. As a minimum, 33% of all spot footings, and one test for every 50 lineal feet of continues wall footings should be tested for each lift.

5.4 Types of Fill

5.4.1 Structural Fill: Sub-base

Well-graded granular soils free of organics, debris, or other deleterious materials are recommended for use as structural fill at this site. We recommend a well-graded sandy gravel material with no less than 5% and no more than 12% passing the #200 sieve and no particles greater than 4 inches in maximum dimension.

5.4.2 Structural Fill: Roadbase

Granular soils, free of organics or other deleterious materials and debris. We recommend a sand and fractured gravel material with between 5 and 12 percent passing the #200 sieve and no particles greater than approximately 1 inch in maximum dimension.

5.4.3 Non-Structural Fill

On-site soils appear in most cases to be suitable for non-structural site grading and landscaping fill. All fill material shall be approved by the engineer prior to placement.

5.5 Quality Control

Our recommendations in this report are based on the assumption that adequate quality control testing and observations will be conducted during construction to verify compliance. This may include but not necessarily be limited to the following:

5.5.1 Field observations

Observations during all phases of construction such as site preparation, foundation excavation, structural fill placement and concrete placement.

5.5.2 Fill Compaction

Compaction testing is required for all Structural supporting fill materials. Maximum Dry Density (Proctor-ASTM 1557) tests should be requested by the contractor immediately after delivery of any granular fill materials. The maximum density information should then be used for field density tests on each lift as necessary to insure that the required compaction is being achieved.

5.5.3 Concrete Quality

We recommend that freshly mixed concrete be tested in accordance with ASTM designations as follows:

- Slump, Temperature, Unit Weight, and Yield testing should be conducted on every delivery trucks (ASTM C 138 and C 143).

- Entrained Air testing should also be conducted on every delivery trucks for exposed concrete or concrete placed above the frost line (ASTM C 231).

- Test cylinders should be taken a minimum of every 50 cubic yards. Cylinder compressive strength tests should be conducted at 7 and 28 days from the placement date (ASTM C 31).

6.0 LIMITATIONS

The recommendations provided herein were developed by, evaluating the information obtained from the borings and site investigation. The borehole data reflects the subsurface conditions only at the specific locations at the particular time designated on the borehole logs. Soil and ground water conditions may differ from conditions encountered at the actual borehole location. The nature and extent of any variation in the borehole may not become evident until during the course of construction. If variations do appear, it may become necessary to re-evaluate the recommendations of this report after we have observed the variation.

Our professional services have been performed, our findings obtained, and our recommendations prepared in accordance with generally accepted geotechnical engineering principles and practices. This warranty is in lieu of all other warranties, either expressed or implied.

We appreciate the opportunity to be of service to you on this project. If we can be of further assistance or if you have any questions regarding this project, please do not hesitate to contact us at (435)-753-2850.

7.0 REFERENCES

ASTM, American Society for Testing and Materials 1997

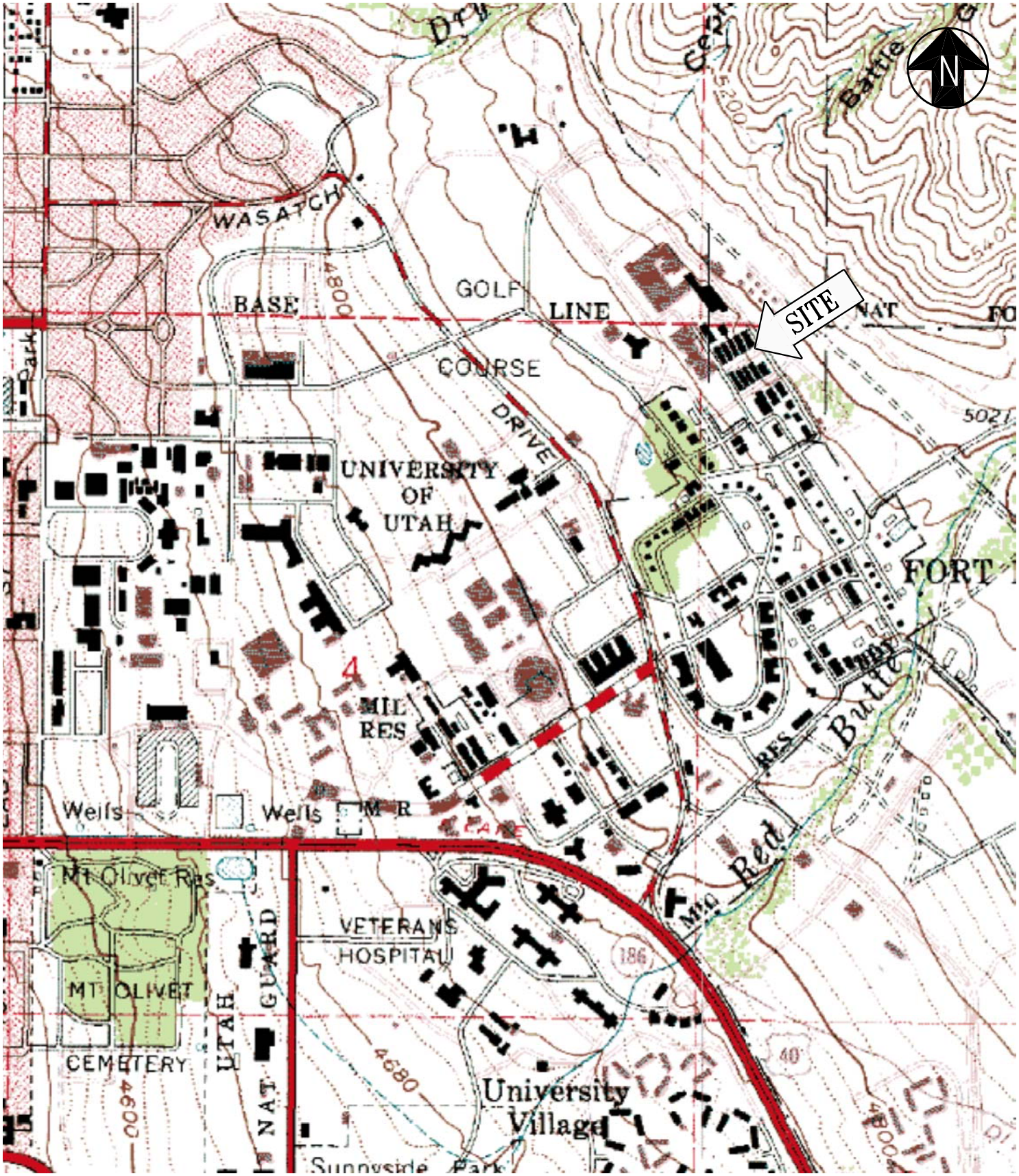
IBC, International Building Code, 2000 Edition, International Conference of Building Officials, Whittier, CA.

Utah Geological Survey, 2002, "Ground-Shaking Map for Magnitude 7.0 Earthquake on the Wasatch Fault Salt Lake City, Utah Metropolitan Area"

Utah Geological and Mineral Survey, Fitzhugh D. Davis, 1983, "Geologic Map of The Central Wasatch Front

U.S. Geological Survey, Scot and Shroba, 1985, "Earthquake Fault Map of Salt Lake County, Utah"

Appendix



UTAH

SORCE: MODIFIED FROM USGS 1992

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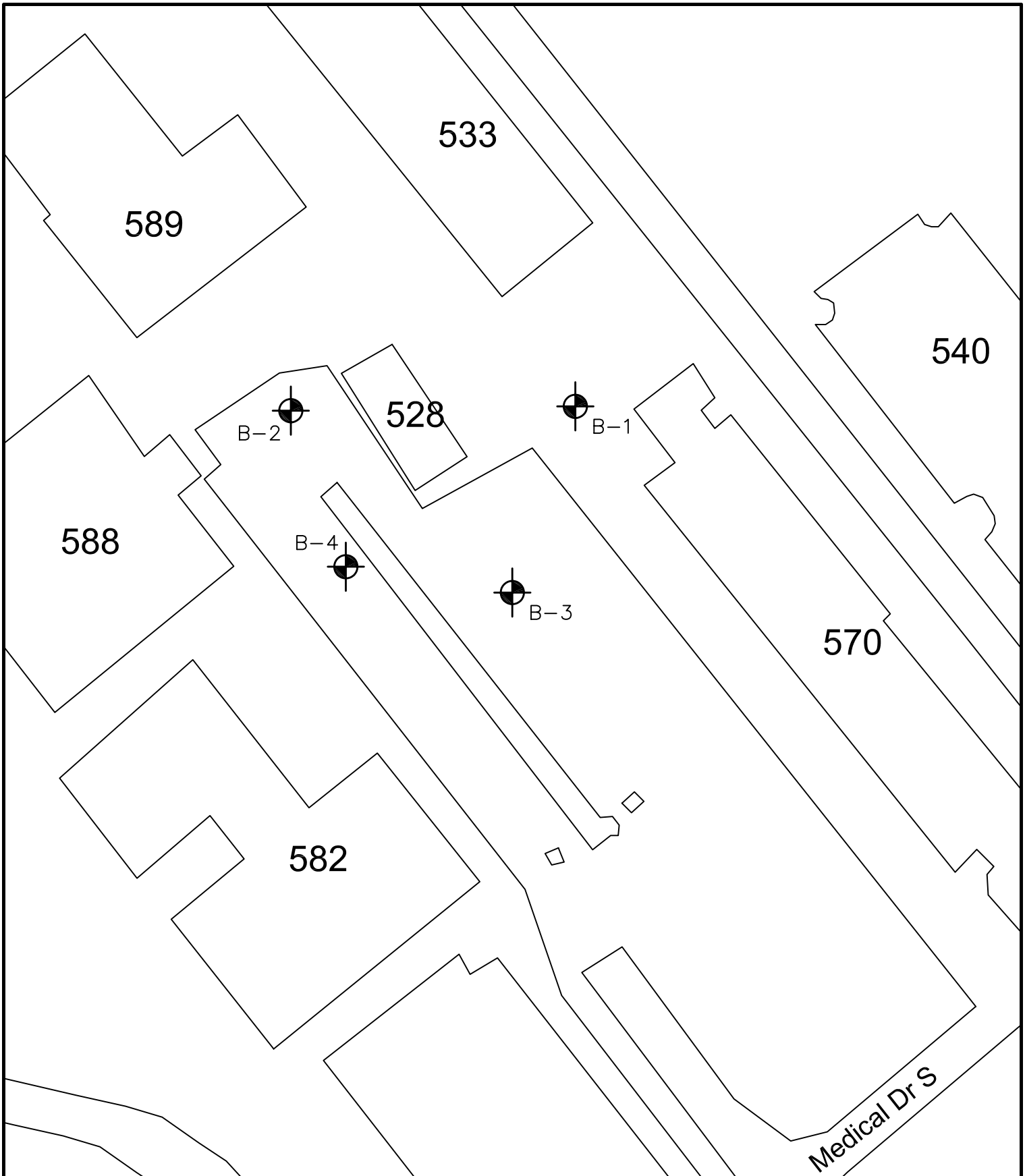
HSEB Site Location

Between Buildings 588 and 570 on U of U Campus

TITLE:	Vicinity Map
SCALE:	SCALE 1:12000
DATE:	10/29/02
DRAWING NO.	102138 Figures.dwg

ENGINEER:	DRAWN BY:
J. Apedaile	J. Apedaile

FIGURE 1



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HSEB Site Location

Between Buildings 588 and 570 on U of U Campus

TITLE:	Site Map		
SCALE:	SCALE No Scale	ENGINEER: J. Apedaile	DRAWN BY: J. Apedaile
DATE:	10/29/02		
DRAWING NO.	102138 Figures.dwg		**FIGURE 2**

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BORING LOG

U of U HSEB Site

BORING No. : B–1	JOB No. : 102138.0	DATE : 10/25/02	SHEET 1 OF 2
PROJECT : U of U HSEB U of U Campus between 588 and 570	SURF. EL. :	BORE DIA. : 6"	DEPTH : 66.5'
	WATER EL. :	COORDINATES:	
BORING TYPE : 6" Odex	CAD FILE : 102138 Figures.dwg		

DEPTH, Ft.	GRAPHIC LOG	SAMPLE	SOIL DESCRIPTION	% FINER No. 200 SIEVE	BLOWS/Ft.	LIQUID LIMIT	PLASTIC LIMIT	MOISTURE CONTENT, %	SHEAR STRENGTH, TSF (● MINIATURE VANE, ⊖ RESIDUAL MINIATURE VANE, ⊗ POCKET PENETROMETER, ◒ UNCONFINED COMPRESSION(UU), ⊕ TORVANE; OPEN SYMBOLS REPRESENT REMOLDED TESTS.) 1.0 2.0	WET/DRY UNIT WT.,lb/cu.ft.
5			Surface~8': Brown silty sandy FILL with rock gravel and brick, moist, dense.		46			10.2		
10				26.4	28			7.8		
15			8'–25': Brown silty SAND (SM); layered with layers of gravel, coarse sands, and traces of clay. dry, medium dense to dense.	25.4 21.9	29			11.4 6.7		
20					>50			3.1		
25					>50			8		
30			25'–41': Lt. brown silty SAND and GRAVEL (SM–GM); dry, very dense to dense.	28.8	>50			8.1		

REMARKS :

REMARKS :

WTR DEPTH @ COMPL. : Not encountered

FIELD ENG.: Jay Apedaile

COMPLETION DATE : 10/25/02

FIGURE 3

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BORING LOG

U of U HSEB Site

BORING No. : B-2	JOB No. : 102138.0	DATE : 10/25/02	SHEET 2 OF 2
PROJECT : U of U HSEB U of U Campus between 588 and 570	SURF. EL. :	BORE DIA. : 6"	DEPTH : 66.5'
	WATER EL. :	COORDINATES:	
BORING TYPE : 6" Odex	CAD FILE : 102138 Figures.dwg		

DEPTH, Ft.	GRAPHIC LOG	SAMPLE	SOIL DESCRIPTION	% FINER No. 200 SIEVE	BLOWS/Ft.	LIQUID LIMIT	PLASTIC LIMIT	MOISTURE CONTENT, %	WET/DRY UNIT WT.,lb/cu.ft.
35			25'-41': Lt. brown silty SAND and GRAVEL (SM-GM); dry, very dense to dense.		>50			7	
40				26.2	35			8.3	
45			41'-47': Lt. brown silty SAND (SM); with gravel and clay in lenses, dry, very dense.		>50	22	16	12	
50			47'-57': Lt. brown silty sandy GRAVEL (GM); some clay in lenses, dry, very dense.		>50			7.6	
55					>50			10.1	
60			57'-66'-6": Lt. brown SILT-CLAY (CL-ML); some sand, gravel and rock, moist, very stiff to hard.		>50	28	20	22.3	
65					>50	21	17	15.3	
			End at Required 66'-6"						

SHEAR STRENGTH, TSF
- ● MINIATURE VANE
- ⊖ RESIDUAL MINIATURE VANE
- ⊗ POCKET PENETROMETER
- ◒ UNCONFINED COMPRESSION(UU)
- ⊕ TORVANE

(OPEN SYMBOLS REPRESENT REMOLDED TESTS.)

1.0 2.0

WTR DEPTH @ COMPL. : Not encountered

FIELD ENG.: Jay Apedaile

COMPLETION DATE : 10/25/02

FIGURE 3a

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BORING LOG

U of U HSEB Site

BORING No. : B-2	JOB No. : 102138.0	DATE : 10/25/02	SHEET 1 OF 2
PROJECT : U of U HSEB U of U Campus between 588 and 570	SURF. EL. :	BORE DIA. : 6"	DEPTH : 46.5'
	WATER EL. :	COORDINATES:	
BORING TYPE : 6" Odex	CAD FILE : 102138 Figures.dwg		

DEPTH, Ft.	GRAPHIC LOG	SAMPLE	SOIL DESCRIPTION	% FINER No. 200 SIEVE	BLOWS/Ft.	LIQUID LIMIT	PLASTIC LIMIT	MOISTURE CONTENT, %	SHEAR STRENGTH, TSF (● MINIATURE VANE, ⊖ RESIDUAL MINIATURE VANE, ⊗ POCKET PENETROMETER, ◒ UNCONFINED COMPRESSION(UU), ⊕ TORVANE; OPEN SYMBOLS REPRESENT REMOLDED TESTS.) 1.0 2.0	WET/DRY UNIT WT.,lb/cu.ft.
			Surface–1': 2.5" Asphalt underlain by 6" to 9" of roadbase.							
5			1'–21': Brown SILT (ML); with clay and sands in lenses, trace of rock, moist, stiff to very stiff.		13					
10					16	25	20	17.8		
15				61	18			14		
20				21.4	30			8.6		
25			21'–40': Brown sandy SILT (ML); with clay in lenses, some gravel and rock, dry, very stiff to hard.	41.6	26			10.5		
30					48	27	16	20.8 13.9		

REMARKS :

REMARKS :

WTR DEPTH @ COMPL. : Not encountered

FIELD ENG.: Jay Apedaile

COMPLETION DATE : 10/25/02

FIGURE 4

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BORING LOG

U of U HSEB Site

BORING No. : B-2	JOB No. : 102138.0	DATE : 10/25/02	SHEET 2 OF 2
PROJECT : U of U HSEB U of U Campus between 588 and 570	SURF. EL. :	BORE DIA. : 6"	DEPTH : 46.5'
	WATER EL. :	COORDINATES:	
BORING TYPE : 6" Odex	CAD FILE : 102138 Figures.dwg		

DEPTH, Ft.	GRAPHIC LOG	SAMPLE	SOIL DESCRIPTION	% FINER No. 200 SIEVE	BLOWS/Ft.	LIQUID LIMIT	PLASTIC LIMIT	MOISTURE CONTENT, %	SHEAR STRENGTH, TSF (● MINIATURE VANE, ⊖ RESIDUAL MINIATURE VANE, ⊗ POCKET PENETROMETER, ◑ UNCONFINED COMPRESSION(UU), ⊕ TORVANE; OPEN SYMBOLS REPRESENT REMOLDED TESTS.) 1.0 2.0	WET/DRY UNIT WT.,lb/cu.ft.
35			21'–40': Brown sandy SILT (ML); with clay in lenses, some gravel and rock, dry, very stiff to hard.		50			9.9		
40					>50			5.9		
45			40'–46'6": Brown sandy silty GRAVEL (GM); dry, dense to very dense.		41			9.9		
			End at Required 45'–6"							
50										
55										
60										

REMARKS :

REMARKS :

WTR DEPTH @ COMPL. : Not encountered

FIELD ENG.: Jay Apedaile

COMPLETION DATE : 10/25/02

FIGURE 4a

CAC CONSULTING ENGINEERS

BORING LOG

U of U HSEB Site

BORING No. : B-3	JOB No. : 102138.0	DATE : 10/25/02	SHEET 1 OF 2
PROJECT : U of U HSEB U of U Campus between 588 and 570	SURF. EL. :	BORE DIA. : 6"	DEPTH : 41.5'
	WATER EL. :	COORDINATES:	
BORING TYPE : 6" Odex	CAD FILE : 102138 Figures.dwg		

DEPTH, Ft.	GRAPHIC LOG	SAMPLE	SOIL DESCRIPTION	% FINER No. 200 SIEVE	BLOWS/Ft.	LIQUID LIMIT	PLASTIC LIMIT	MOISTURE CONTENT, %	SHEAR STRENGTH, TSF (● MINIATURE VANE, ⊖ RESIDUAL MINIATURE VANE, ⊗ POCKET PENETROMETER, ◒ UNCONFINED COMPRESSION(UU), ⊕ TORVANE; OPEN SYMBOLS REPRESENT REMOLDED TESTS.) 1.0 2.0	WET/DRY UNIT WT.,lb/cu.ft.
			Surface–1': 2.5" Asphalt underlain by 6" to 9" of roadbase.							
5				50.7	6			10.3		
10			1'–24': Brown SILT (ML); with clay and sands in lenses, trace of rock, moist, stiff to very stiff.	71.1	10			15.2		
15				68.6	22			13.3		
20				75.8 28.8	18			24.8 11.2		
25			24'–33': Brown silty SAND and GRAVEL (SM–GM); some rock, dry, very dense.	28.1	>50			7		
30					>50			5.4		

REMARKS :

REMARKS :

WTR DEPTH @ COMPL. : Not encountered

FIELD ENG.: Jay Apedaile

COMPLETION DATE : 10/26/02

FIGURE 5

CAC CONSULTING ENGINEERS

BORING LOG

U of U HSEB Site

BORING No. : B-3	JOB No. : 102138.0	DATE : 10/25/02	SHEET 2 OF 2
PROJECT : U of U HSEB U of U Campus between 588 and 570	SURF. EL. :	BORE DIA. : 6"	DEPTH : 41.5'
	WATER EL. :	COORDINATES:	
BORING TYPE : 6" Odex	CAD FILE : 102138 Figures.dwg		

DEPTH, Ft.	GRAPHIC LOG	SAMPLE	SOIL DESCRIPTION	% FINER No. 200 SIEVE	BLOWS/Ft.	LIQUID LIMIT	PLASTIC LIMIT	MOISTURE CONTENT, %	SHEAR STRENGTH, TSF (● MINIATURE VANE, ⊖ RESIDUAL MINIATURE VANE, ⊗ POCKET PENETROMETER, ◒ UNCONFINED COMPRESSION(UU), ⊕ TORVANE; OPEN SYMBOLS REPRESENT REMOLDED TESTS.) 1.0 2.0	WET/DRY UNIT WT.,lb/cu.ft.
			24'–33': Brown silty SAND and GRAVEL (SM–GM); some rock, dry, very dense.							
35			33'–40': Lt. brown gravelly CLAY (CL); with sands and some rock, moist to dry, very stiff.		23	28	20	26.8		
40			40'–41'6": Lt brown clayey GRAVEL (GC); with sands, dry, dense.		30			10		
			End at Required 41'–6"							
45										
50										
55										
60										

REMARKS :

REMARKS :

WTR DEPTH @ COMPL. : Not encountered

FIELD ENG.: Jay Apedaile

COMPLETION DATE : 10/26/02

FIGURE 5a

CAC CONSULTING ENGINEERS

BORING LOG

U of U HSEB Site

BORING No. : B-4	JOB No. : 102138.0	DATE : 10/26/02	SHEET 1 OF 1
PROJECT : U of U HSEB U of U Campus between 588 and 570	SURF. EL. :	BORE DIA. : 6"	DEPTH : 41.5'
	WATER EL. :	COORDINATES:	
BORING TYPE : 6" Odex	CAD FILE : 102138 Figures.dwg		

DEPTH, Ft.	GRAPHIC LOG	SAMPLE	SOIL DESCRIPTION	% FINER No. 200 SIEVE	BLOWS/Ft.	LIQUID LIMIT	PLASTIC LIMIT	MOISTURE CONTENT, %	SHEAR STRENGTH, TSF (● MINIATURE VANE, ⊖ RESIDUAL MINIATURE VANE, ⊗ POCKET PENETROMETER, ◒ UNCONFINED COMPRESSION(UU), ⊕ TORVANE; OPEN SYMBOLS REPRESENT REMOLDED TESTS.) 1.0 2.0	WET/DRY UNIT WT.,lb/cu.ft.
			Surface–1': 2.5" Asphalt underlain by 6" to 9" of roadbase.							
5			1'–14': Brown silty SAND (SM); with gravel, trace of rock, dry, dense.	26.1	50			6		
10				22.9	48			5.8		
15			14'–21': Brown sandy SILT (ML); with gravel, trace of clay, mois to wet, stiff.	75.9	14			24.4		
20					>50			25.6		
25			21'–26'6": Brown silty GRAVEL (GM); some rock, trace of clay, dry, very dense.	34.2	>50			9.5		
30										

REMARKS :

REMARKS :

WTR DEPTH @ COMPL. : Not encountered

FIELD ENG.: Jay Apedaile

COMPLETION DATE : 10/26/02

FIGURE 6

UNIFIED SOIL CLASSIFICATION SYSTEM

FIELD IDENTIFICATION PROCEDURES				GRAPH SYMBOL	LETTER SYMBOL [1]	TYPICAL DESCRIPTIONS
COARSE GRAINED SOILS More than half of material is larger than No. 200 sieve size. [2] (The No. 200 sieve size is about the smallest particle visible to the naked eye)	GRAVELS More than half of coarse fraction is larger than No. 4 sieve size. (For visual classifications, the 1/4" size may be used as equivalent to the No. 4 sieve size.)	CLEAN GRAVELS (Little or no fines)	Wide range in grain size and substantial amounts of all intermediate particle sizes.		GW	Well graded gravels, gravel-sand mixtures, little or no fines.
			Predominantly one size or a range of sizes with some intermediate sizes missing.		GP	Poorly graded gravels, gravel-sand mixtures, little or no fines.
		GRAVELS WITH FINES (Appreciable amount of fines)	Non-plastic fines (for identification procedures see ML below).		GM	Silty gravels, poorly graded gravel-sand-silt mixtures.
			Plastic fines (for identification procedures see CL below).		GC	Clayey gravels, poorly graded gravel-sand-clay mixtures.
	SANDS More than half of coarse fraction is smaller than No. 4 sieve size. (For visual classifications, the 1/4" size may be used as equivalent to the No. 4 sieve size.)	CLEAN SANDS (Little or no fines)	Wide range in grain sizes and substantial amounts of all intermediate particle sizes.		SW	Well graded sands, gravelly sands, little or no fines.
			Predominantly one size or a range of sizes with some intermediate sizes missing.		SP	Poorly graded sands, gravelly sands, little or no fines.
		SANDS WITH FINES (Appreciable amount of fines)	Non-plastic fines (for identification procedures see ML below).		SM	Silty sands, poorly graded sand-silt mixtures.
			Plastic fines (for identification procedures see CL below).		SC	Clayey sands, poorly graded sand-clay mixtures.
FINE GRAINED SOILS More than half of material is smaller than No. 200 sieve size. (The No. 200 sieve size is about the smallest particle visible to the naked eye)	IDENTIFICATION PROCEDURES ON FRACTION SMALLER THAN No. 40 SIEVE SIZE	DRY STRENGTH (CRUSHING CHARACTERISTICS)	DILATANCY (REACTION TO SHAKING)	TOUGHNESS (CONSISTENCY NEAR PLASTIC LIMIT)		
	SILTS AND CLAYS Liquid limit less than 50	None to slight	Quick to slow	None		ML	Inorganic silts and very fine sands, rock flour, silty or clayey fine sand with slight plasticity.
		Medium to high	None to very slow	Medium		CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays.
		Slight to medium	Slow	Slight		OL	Organic silts and organic silt-clays of low plasticity.
	SILTS AND CLAYS Liquid limit greater than 50	Slight to medium	Slow to none	Slight to medium		MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts.
		High to very high	None	High		CH	Inorganic clays of high plasticity, fat clays.
		Medium to high	None to very slow	Slight to medium		OH	Organic clays of medium to high plasticity.
HIGHLY ORGANIC SOILS		Readily identified by color, odor, spongy feel and frequently by fibrous texture.				Pt	Peat and other highly organic soils.

[1] Boundary classifications: —Soils possessing characteristics of two groups are designated by combinations of group symbols. For example GW—GC, well graded gravel—sand mixture with clay binder.
[2] All sieve sizes on this chart are U.S. standard.

GENERAL NOTES

1. In general, Unified Soil Classification Designations presented on the logs were evaluated by visual methods only. There rore, actual desIgnatIons (based on laboratory testing) may dIffer.

2. Lines seperating strata on the logs represent approximate boundaries only Actual transItIons may be gradual.

3. Logs represent general soil conditions observed at teh point of exploration onthe date indicated.

4. No warranty Is provIded as to the contInuIty of soIl condItIons between individual sample locations.

FINE - GRAINED SOIL

CONSISTENCY	SPT (blows/ft)	TORVANE UNDRAINED SHEAR STRENGTH (tsf)	POCKET PENETROMETER UNCONFINED COMPRESSIVE STRENGTH (tsf)	FIELD TEST
Very Soft	<2	<0.125	<0.25	Easily penetrated several inches by Thumb. Squeezes through fIngers.
Soft	2 - 4	0.125 - 0.25	0.25 - 0.5	Easily penetrated 1 " by Thumb . Molded by light finger pressure.
Medium Stiff	4 - 8	0.25 - 0.5	0.5 - 1.0	Penetrated over 1/2 " by Thumb with moerate effort. Molded by strong finger pressure.
Stiff	8 - 15	0.5 - 1.0	1.0 - 2.0	Indented about 1/2 " by Thumb but penetrated only wIth great effort
Very Stiff	15 - 30	1.0 - 2.0	2.0 - 4.0	Readily indented by Thumbnail
Hard	>30	>2.0	>4.0	Indented wIth dIfficulty by Thumbnail

LOG KEY SYMBOLS

Bulk / Bag Sample
Rock Core
Standard Penetration Split Spoon Sampler
No Recovery
Shelby Tube
Water Level (level after completion)
Water Level (level where first encountered)

COARSE -GRAINDE SOIL

APPERENT DENSITY	SPT (blows/ft)	RELATIVE DENSITY (%)	FIELD TEST
Very Loose	<4	0 - 15	Easily penetrated with 1/2 " reinforcing rod pushed by hand
Loose	4 - 10	15 - 35	Difficult to penetrated with 1/2 " reinforcing rod pushed by hand
Medium Dense	10 - 30	35 - 65	Easily penetrated a foot with 1/2 " reinforcing rod driven with 5-lb hammer
Dense	30 - 50	65 - 85	Difficult to penetrated a foot with 1/2 " reinforcing rod driven with 5-lb hammer
Very Dense	>50	85 - 100	Penetrated only a few inches with 1/2 " reinforcing rod driven with 5-lb hammer

STRATIFICATION

DESCRIPTION	THICKNESS
SEAM	1/16 - 1/2 "
LAYER	1/2 - 12 "

DESCRIPTION	THICKNESS
Occasional	One or less per foot of thickness
Frequent	More than on per foot of thIckness

CEMENTATION

DESCRIPTION	DESCRIPTION
Weakely	Crumbles or breaks with handling of slight finger pressure
Moderately	Crumbles or breaks with considerable finger pressure
Strongly	Will not crumbles or breaks with finger pressure

MODIFIERS

DESCRIPTION	%
Trace	<5
Some	5 - 12
WIth	>12

MOISTURE CONTENT

DESCRIPTION	FIELD TEST
Dry	Absence of moIsture, dusty, dry to the touch
Moist	Damp but no visible water
Wet	VIsIble water, usually soil below Water Table

FIGURE 7

SUMMARY OF TEST DATA

HOLE NO./ SAMPLE NO.	DEPTH BELOW GROUND SURFACE	STANDARD PENETRATION BLOWS PER FOOT	IN-PLACE DENSITY		GRADATION			TORVANE SHEAR TONS/FT.^{2}	ATTERBERG LIMITS			SOIL CLASSIFICATION UNIFIED SYSTEM
			UNIT WEIGHT WET/DRY LB./FT.^{3}	MOISTURE PERCENT	% SAND	% GRAVEL	% PASSING NO. 200 SIEVE		L.L.	P.L.	P.I.	
1/1	5'	46		10.2								FILL
1/2	10'	28		7.8	40.1	33.5	26.4					SM-GM
1/3	15'	29		11.4	74.6		25.4					SM
1/4	16'			6.7	76.3	1.8	21.9					SM
1/5	20'	> 50		3.1								GM-SM
1/6	25'	> 50		8								GM-SM
1/7	30'	> 50		8.1	31.3	39.9	28.8					GM-SM
1/8	35'	> 50		7								GM-SM
1/9	40'	35		8.3	39.9	33.9	26.2					GM-SM
1/10	45'	> 50		12					22	16	6	CL-ML
1/11	50'	> 50		7.6								SM
1/12	55'	> 50		10.1								GM-SM
1/13	60'	> 50		22.3					28	20	8	CL
1/14	65'	> 50		15.3					21	17	4	ML

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FIGURE 8

SUMMARY OF TEST DATA

HOLE NO./ SAMPLE NO.	DEPTH BELOW GROUND SURFACE	STANDARD PENETRATION BLOWS PER FOOT	IN-PLACE DENSITY		GRADATION			TORVANE SHEAR TONS/FT.^{2}	ATTERBERG LIMITS			SOIL CLASSIFICATION UNIFIED SYSTEM
			UNIT WEIGHT WET/DRY LB./FT.^{3}	MOISTURE PERCENT	% SAND	% GRAVEL	% PASSING NO. 200 SIEVE		L.L.	P.L.	P.I.	
2/1	5'	13										ML
2/2	10'	16		17.8					25	20	5	CL-ML
2/3	15'	18		14	39		61					ML
2/4	20'	>50		8.6	69.2	9.4	21.4					SM
2/5	25'	26		10.5	44.8	13.6	41.6					SM-ML
2/6	30'	48		20.8					27	16	11	CL
2/7	30.5'			13.9								ML
2/8	35'	50		9.9								ML
2/9	40'	>50		5.9								GM
2/10	45'	41		9.9								GM

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FIGURE 9

SUMMARY OF TEST DATA

HOLE NO./ SAMPLE NO.	DEPTH BELOW GROUND SURFACE	STANDARD PENETRATION BLOWS PER FOOT	IN-PLACE DENSITY		GRADATION			TORVANE SHEAR TONS/FT.^{2}	ATTERBERG LIMITS			SOIL CLASSIFICATION UNIFIED SYSTEM
			UNIT WEIGHT WET/DRY LB./FT.^{3}	MOISTURE PERCENT	% SAND	% GRAVEL	% PASSING NO. 200 SIEVE		L.L.	P.L.	P.I.	
3/1	5'	6		10.3			50.7					ML
3/2	10'	10		15.2			71.1					ML
3/3	15'	22		13.3			68.6					ML
3/4	20'	18		24.8			75.8					ML-CL
3/5	21'			11.2	68	3.2	28.8					SM
3/6	25'	>50		7	32.9	39	28.1					GM-SM
3/7	30'	>50		5.4								GM-SM
3/8	35'	23		26.8					28	20	8	CL
3/9	40'	30		10								GC
4/1	5'	50		6	49.9	24	26.1					SM
4/2	10'	48		5.8	37.9	39.2	22.9					GM-SM
4/3	15'	14		24.4			75.9					ML
4/4	20'	>50		25.6								SM-ML
4/5	25'	>50		9.5	25.4	40.4	34.2					GM

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FIGURE 10